CMOS Photon-Counting Image Sensor with High Spatial Resolution and Room Temperature Operation for High-Performance Visible-Blind UV/EUV Photon Number Resolving, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

In this proposed project, we plan to further develop a novel platform image sensor, Quanta Image Sensor (QIS), for future NASA missions, and other scientific and consumer applications. The outcome of this project will be a large-format visible-blind CMOS UV/EUV photon-counting sensor with accurate photon-counting capability. The novel sensor will provide some capabilities that are not available with other high-sensitivity detectors, such as accurate photon-number-resolving, zero dead time, low voltage and power requirements, high spatial resolution, and room temperature operation. These features will benefit multiple future NASA missions such as the ESA-NASA Solar Orbiter, Large UV Optical Infrared Survey Telescope (LUVOIR), and the Habitable Exoplanet Mission (HabEx).

The core of QIS is the specialized CMOS photon-counting pixels, called "jots." With our patented innovations, jots can accurately count photons without the use of avalanche gain or cooling. The technology was validated in a 1Mpixel prototype. The accurate photon-counting capability was demonstrated with ultra-low read noise and dark current at room temperature. When combined with the existing advanced back-surface passivation techniques and band-pass filters developed for CCDs and standard CMOS image sensors, a visible-blind QIS with high quantum efficiency in UV/EUV wavelengths can be produced.

The ultimate goal of the project is to produce a QIS for high-performance visible-blind photon-counting in the UV/EUV spectral region. The effort in Phase I can provide critical guidance for the prototype design in Phase II. The anticipated results are (1) a detailed manufacturing plan for combining the future QIS products with the advanced back-surface passivation techniques, (2) an optimized jot designed for higher quantum efficiency and less cross-talk especially with short photon absorption depth, and (3) a preliminary plan on modifications required for the radiation hardened detector and circuit design.

Anticipated Benefits

The applications include a wide range of astrophysics studies. For example, the studies of exoplanet atmospheres, surface reflectance, proto-planets, and the intergalactic and circumgalactic medium. The outcome of this project will benefit the flagship NASA missions such as LUVOIR, HabEx, and ESA-NASA Solar Orbiter. Besides, the potential product will be the only type of detector that can provide the photon number resolving capability to enable accurate UV/EUV quantum yield measurements.

The outcome of this project is also beneficial to other scientific applications. For example, the high-energy particle physics experiments with the Large Hadron Collider (LHC), life science fluorescence microscopy, and chemistry studies such as flow cytometry. There are also sizeable markets in medical

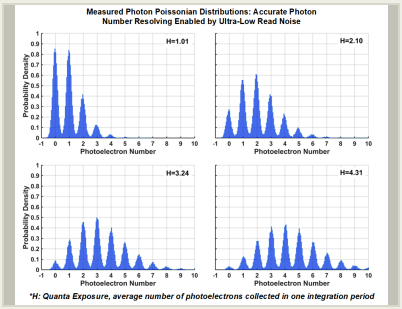

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Table of Contents

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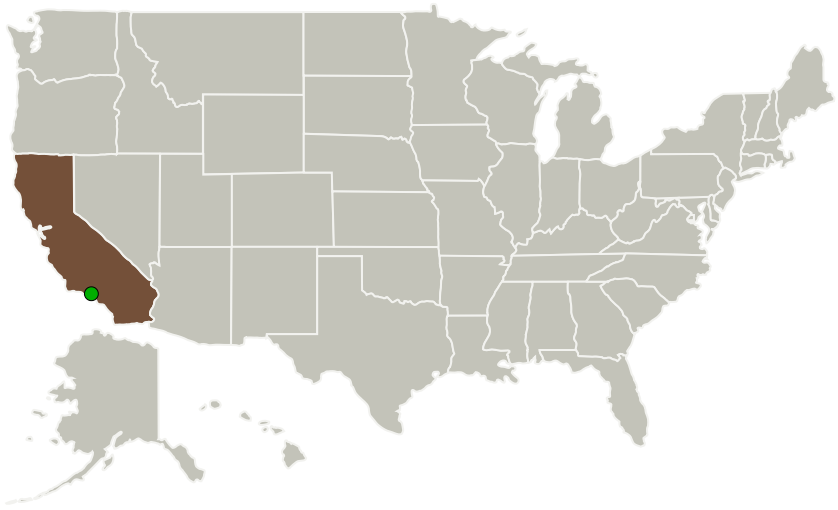
dermatology imaging, high-resolution surface inspection in automotive and industrial applications, and flame detection.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Gigajot Technology, LLC	Lead Organization	Industry	Pasadena, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Gigajot Technology, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

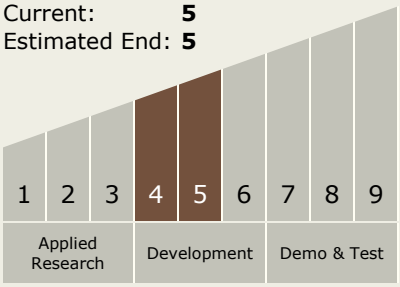
Carlos Torrez

Principal Investigator:

Jiaju Ma

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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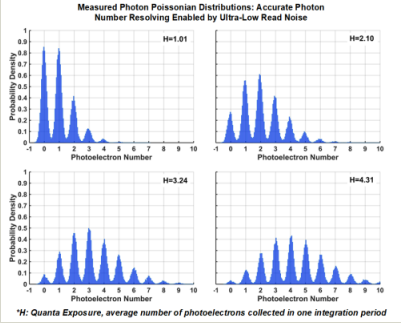
February 2019: Closed out

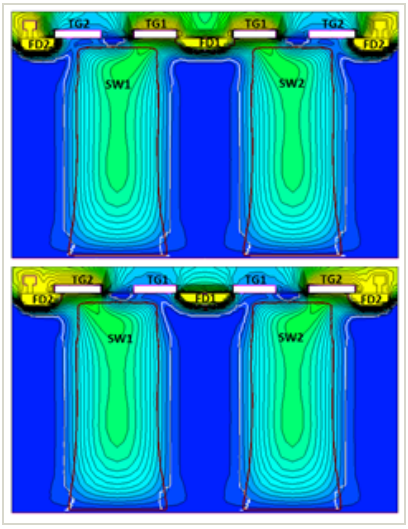
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140967)*

Images



Briefing Chart Image
CMOS Photon-Counting Image Sensor with High Spatial Resolution and Room Temperature Operation for High-Performance Visible-Blind UV/EUV Photon Number Resolving, Phase I
(https://techport.nasa.gov/image/136683)



Final Summary Chart Image
CMOS Photon-Counting Image Sensor with High Spatial Resolution and Room Temperature Operation for High-Performance Visible-Blind UV/EUV Photon Number Resolving, Phase I
(https://techport.nasa.gov/image/135452)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destinations

The Sun, Outside the Solar System